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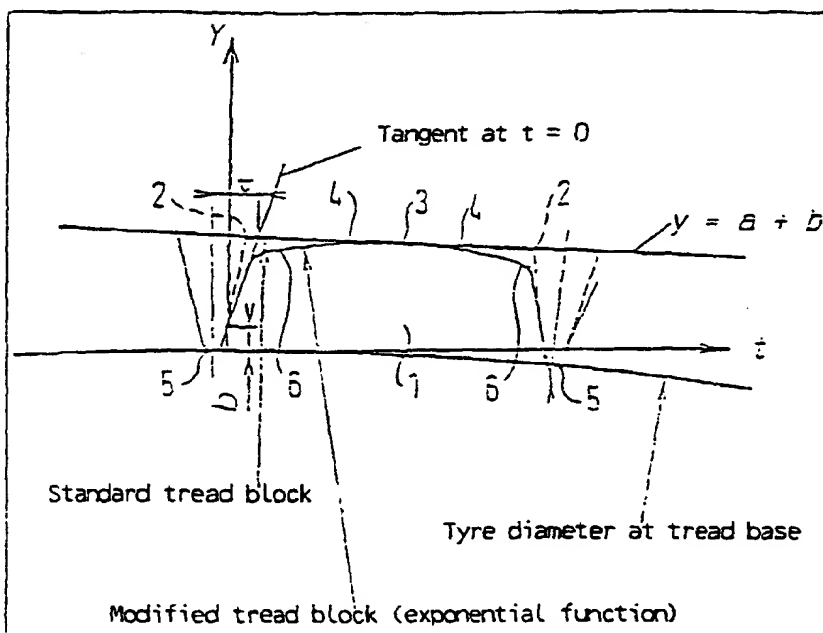
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(54) Title: A VEHICLE TYRE HAVING A PROFILED TREAD



(57) Abstract: A vehicle having a profiled tread, having tread blocks (1) in at least some regions of its circumference, characterised in that for at least some of the tread blocks (1) at least the tread block edges (2) running into the tyre contact patch (11) and extending at an angle to the central plane of the tyre are lowered over their entire length with respect to the central plateau (3) of the respective tread block (1).

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A VEHICLE TYRE HAVING A PROFILED TREAD

TECHNICAL FIELDS

The invention relates to a vehicle tyre having a profiled tread, having tread blocks in at least some regions of its circumference.

BACKGROUND ART

It is known, in particular for so-called block treads, but also for treads having a relatively large proportion of tread blocks with a surface radius based on the tyre diameter or the mould radius, that irregular wear in the form of heel and toe wear frequently occurs. This heel and toe wear can occur in a particularly severe manner in treads used on the driven axles of trucks. While known tread block designs having correspondingly sharp tread block edges produce good grip values, loud rolling noise has to be accepted in addition to the disadvantage of irregular wear, and the small compression zone occurring at the relevant tread block leads to high contact pressure and to tread deformation in the leading edge, which can, in turn, result in higher flexing work, an increase in temperature, unstable rolling and a lower service life.

It is already known from EP 0 895 876 A2 to reduce these disadvantages by designing the corner regions of the tread blocks in a chamfered manner and thus to reduce the tread block height in the corner regions. While this

measure can provide certain improvements, it does not solve the problems listed above to the required extent.

It is the object of the present invention to provide in a vehicle pneumatic tyre having a profiled tread, and tread blocks in at least some regions of its circumference, a tread block design which avoids irregular wear in the form of heel and toe wear, leads to a substantial reduction in rolling noise, reduces the rolling resistance and increases the service life and so the running performance of the tyre.

DISCLOSURE OF THE INVENTION

According to the present invention this object is essentially solved by providing at least some of the tread blocks by at least the tread block edges running into the tyre contact patch and extending at an angle to the central plane of the tyre being lowered over their entire length with respect to the central plateau of the respective tread block.

The contour of the tread block boundary surface or surfaces extending from the start of the lowering preferably up to the base of the groove preferably extends in section planes parallel to the central plane of the tyre in the form of an extended S-curve and, in accordance with a particularly advantageous embodiment, in accordance with an exponential function.

This design of treads can be used in the best possible manner for all purposes by, in particular, the selection

of optimised exponential functions, with it being of particular importance that in accordance with the invention and in contrast to known measures that the tread design is executed in an optimum manner right from the groove base, with the parameters of the exponential function being capable of being selected so that both a directional dependence of the tread on the running direction and a lack of directional dependence of the tread on the running direction result.

BRIEF DESCRIPTION OF DRAWINGS

Particularly advantageous features and aspects of the invention are given in the dependent claims and are described with reference to embodiments with reference to the drawings in which:

Fig. 1 shows a schematic representation to explain the tread modification in accordance with the invention in respect to a standard tread profile;

Fig. 2 shows a representation of a special case of Fig. 1;

Fig. 3 shows a detailed representation of an exponential function for tread optimisation in accordance with the invention; and

Figs. 4, 5 and 6 show schematic representations of various aspects of tread block designs in the outer shoulder of tyres.

MODE FOR CARRYING OUT THE INVENTION

Fig. 1 shows, in a co-ordinate system having a Y axis corresponding to the tread depth and a t axis corresponding to the tread block length, a tread block 1, which is shown starting from the tread base as a standard tread block in the form of a broken line and in a solid line as a tread block in accordance with the invention.

The standard tread block has sharp-edged tread block edges 2 which lead to high rolling noise in operation. Due to the edged or sharp-edged design of conventional tread blocks, a small compression zone is produced in the edge region 2 which leads to high contact pressure and tread deformation in the leading edge. Due to the high flexing work which then occurs and to the associated increase in temperature, decreases in service life result and, furthermore, uneven rolling behaviour can occur. It has already been emphasised that with such a tread block design the good grip has to be acquired at the expense of the so-called heel and toe wear.

The tread block 1 designed in accordance with the invention and shown by solid lines differs from the standard tread block above all by the fact that the tread block edges 2 are lowered over their entire length with respect of the central plateau 3 and the contour of the tread block boundary surface 6 extending from the start 4 of the lowering, preferably up to the groove base 5, extends in section planes parallel to the central plane of the tyre in the form of an extended S-curve and preferably and in accordance with the representation in

Fig. 1 in accordance with an exponential function, i.e. the tread design is designed in an optimum manner right from the groove base.

Fig. 1 shows the general case of the tread block design in accordance with the invention, in accordance with which the start of the tread block boundary surface 6 running in accordance with an exponential function can also be varied with respect to the tread base, as is shown by the parameter b.

The exponential function relating to this general case can be given as follows:

$$Y = a(1 - e^{-t/\tau}) + b$$

The value τ is given by the distance of the intersection of the tangent at the tread block boundary surface 6 at $t = 0$ and the Y axis.

The representation in Fig. 2 corresponds essentially to the representation of Fig. 1; however, it relates to the special case of $b = 0$, i.e. the special shape of the tread block boundary surface designed in accordance with the invention extending up to the groove base 5.

The leading and trailing boundary surfaces 6 of the tread blocks can have the same or different designs with regard to their shapes and/or inclinations. The trailing boundary surfaces are preferably steeper.

In addition to the predominantly desired largest possible elimination of heel and toe wear, the design of tread

blocks in accordance with the invention also achieves a high reduction in rolling noise and a reduction in the rolling resistance. Due to the shape of the tread block boundary surfaces 6, a relatively large compression zone is achieved which, in turn, leads to a low contact pressure with low tread deformation in the leading edge. This results in a reduction in flexing work and temperature so that the service life and the running performance is also increased with a good wear pattern. Another advantage which must be mentioned is that the design allows both a reduction in groove cracking and a minimisation of the block/tread striking contact to be achieved.

Fig. 3 shows in detail, in a co-ordinate system having the tread depth shown on the Y axis and the tread block length shown in the t axis, the shape of an exponential function for the optimisation of treads, with the tread block chamfering of a standard tread block being shown as marked with rectangles and with the shape of a tread block boundary surface 6 in accordance with the invention being entered in relation thereto and marked with triangles. It has already been pointed out that any profile can be optimised by means of the variables t , a , b and τ with regard to the already mentioned advantages which can be aimed at specifically in an individual case. This can be done both in the circumferential or lateral direction or in a combination of both directions. Using these design possibilities, a rectangular or also a trapezoid tread block plateau 3 can result between the start of the leading and the trailing edge lowerings in an elevated view.

It can be of special advantage if the depth of the grooves separating the tread blocks from one another in the direction of the tyre circumference is selected differently in a pre-determinable repetition sequence, in particular if alternating grooves of full depth and half depth are provided. Such a design primarily has a positive effect in special uses of the tyres with corresponding treads in the construction area, in stone quarries and, for example, also on refuse collection vehicles.

Fig. 4 shows a first aspect of a tread design in the outer shoulder of a vehicle tyre, with the drawn-in groove angle at the leading edge of the tread, i.e. as the tread runs into the tyre contact patch 11, being 17° in the tread blocks 9 modified in accordance with the invention, in comparison to the standard tread block 8 and 11° at the trailing edge of the tread. The mould radius is indicated here with the reference numeral 10.

With this tread design, it is the lowering of the tread block edges in comparison to the standard tread block which is important, with this lowering being effected over the entire width of the tread block.

The type of lowering, or design of the tread block boundary surfaces 6, is effected here so that the tread block boundary surface 6 at the tread entry is composed of a flat inclined surface and a surface curved in accordance with a pre-determinable radius which then merges into the central plateau 3. In the embodiment according to Fig. 4, at the tread run-out, the transition

between the flat tread block boundary surface starting from the groove base and the surface running in accordance with a radius and leading to the central plateau has an edged form.

The embodiment of Fig. 5 essentially differs from the embodiment of Fig. 4 by different groove angles at the tread entry and the tread run-out, with the special feature to be seen in the combination of a relatively large tread entry angle with a groove angle of 0° at the tread run-out. However, in this design, the tread edges of the tread block modified in accordance with the invention are also lowered relative to the tread edges of the standard tread block.

Fig. 6 shows a further embodiment with respect to the tread designs of Figs. 4 and 5, with a lowering of the tread blocks being provided only at the tread entry side in comparison to the standard tread block shown by a broken line and with the tread block boundary surface 6 being formed by an inclined surface essentially starting from the groove base and a shorter inclined surface of greater inclination achieved by edge cut-off.

REFERENCE NUMERAL LIST

1	Tread block
2	Tread block edges
3	Central plateau
4	Start of lowering
5	Groove base
6	Tread block boundary surface
7	Groove
8	Standard tread block
9	Modified tread block
10	Surface radius
11	Tyre contact patch

CLAIMS

1. A vehicle having a profiled tread, having tread blocks (1) in at least some regions of its circumference, characterised in that for at least some of the tread blocks (1) at least the tread block edges (2) running into the tyre contact patch (11) and extending at an angle to the central plane of the tyre are lowered over their entire length with respect to the central plateau (3) of the respective tread block (1).

2. A vehicle tyre in accordance with claim 1, characterised in that the contour of the tread block boundary surface (6) extending from the start (4) of the lowering preferably up to the base, of the groove extends in section planes parallel to the central plane of the tyre in the form of an extended S-curve.

3. A vehicle tyre in accordance with claim 2, characterised in that the turning point of the S-curve is disposed in the lower third of the tread block height.

4. A vehicle tyre in accordance with claim 1, characterised in that the contour of the tread block boundary surface (6) extending from the start (4) of the lowering, preferably up to the groove base (5), extends in section planes parallel to the central plane of the tyre in accordance with an exponential function.

5. A vehicle tyre in accordance with claim 4, characterised in that the exponential function is defined by the formula

$$y = a(1 - e^{-t/\tau}) + b$$

with the parameters a , b , τ being freely selectable and defined by the associated Figures.

6. A vehicle tyre in accordance with one of the preceding claims, characterised in that the tread block edges running out of the tyre contact patch are formed analogously to the entry edges.

7. A vehicle tyre in accordance with claim 6, characterised in that the profiles of the entry and run-out boundary surfaces (6) of the tread blocks, which each at least substantially follow an exponential function in shape are designed differently with respect to their shape and/or inclination.

8. A vehicle tyre in accordance with claim 7, characterised in that the run-out boundary surfaces (6) extend more steeply than the entry boundary surfaces.

9. A vehicle tyre in accordance with one of the preceding claims, characterised in that the tread block plateau disposed between the entry side and exit side lowerings amounts to approximately 20% to 80% and preferably about 30% to 50% of the block length.

10. A vehicle tyre in accordance with one of the preceding claims, characterised in that the tread block plateau (3) between the start of the entry side and exit side lowering is rectangular or trapezium-shaped in plan view.

11. A vehicle tyre in accordance with one of the preceding claims, characterised in that the steepness of the entry side and/or exit side tread block boundary surface (6) differs over their width.

12. A vehicle tyre in accordance with one of the preceding claims, characterised in that the depth of the grooves (7) which separate the tread blocks (1) from one another in the circumferential direction of the tyre differs in a pre-determinable repetition sequence.

13. A vehicle tyre in accordance with claim 12, characterised in that a groove (7) of pre-determinable depth is respectively followed by a groove (7) of smaller depth, with a change preferably being provided between a groove (7) of full depth and a groove of half depth.

14. A vehicle tyre, in particular in accordance with one of the preceding claims, characterised in that the groove angle in the tread entry is disposed in the range between 15' and 25' and the tread run-out angle is disposed in the range from 0' to 13'.

15. A vehicle tyre in accordance with claim 14, characterised in that at least the entry side tread block boundary surface (6) is formed substantially as an essentially flat inclined surface starting from the base of the groove which merges in the upper quarter of the tread block height via a pre-determinable radius or a broken entry edge into the tread block plateau (3).

FIG. 1

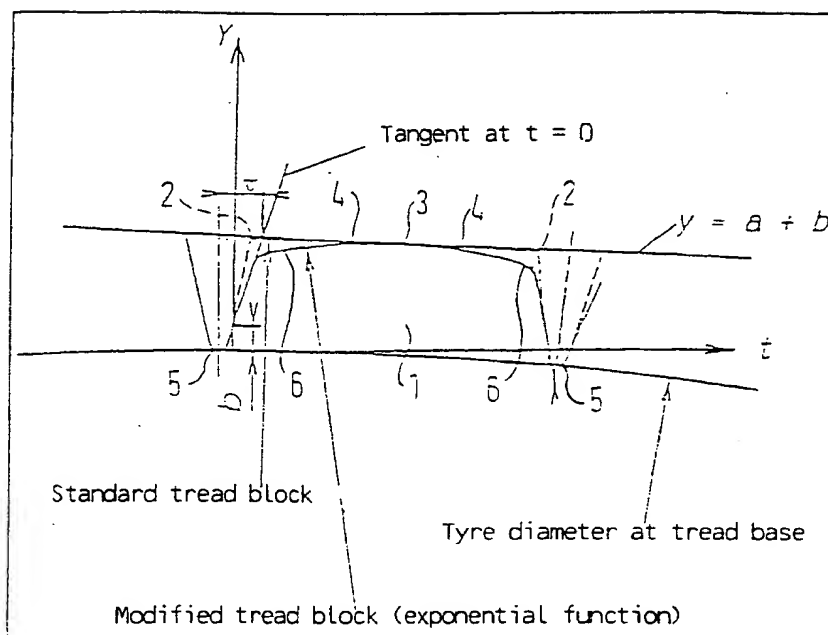


FIG. 2

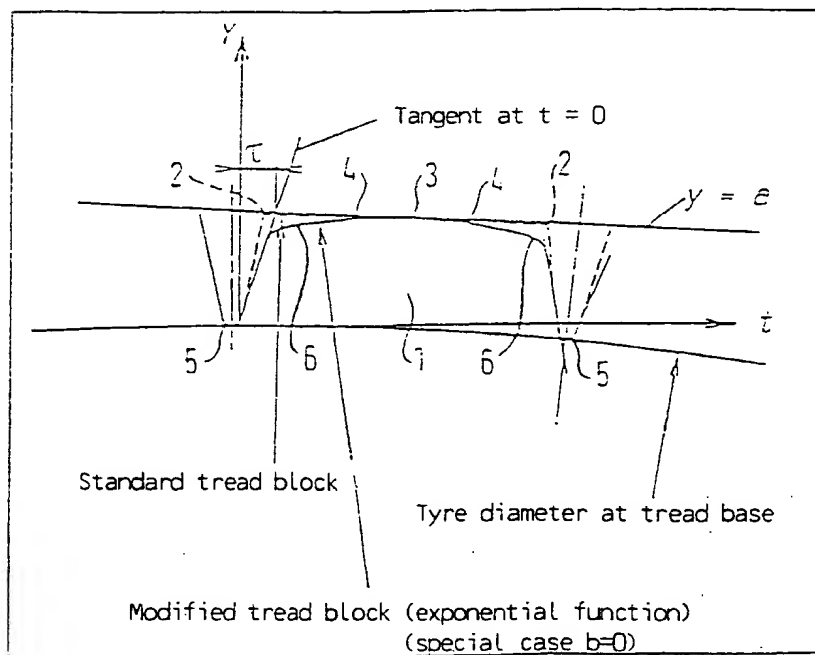


FIG. 3

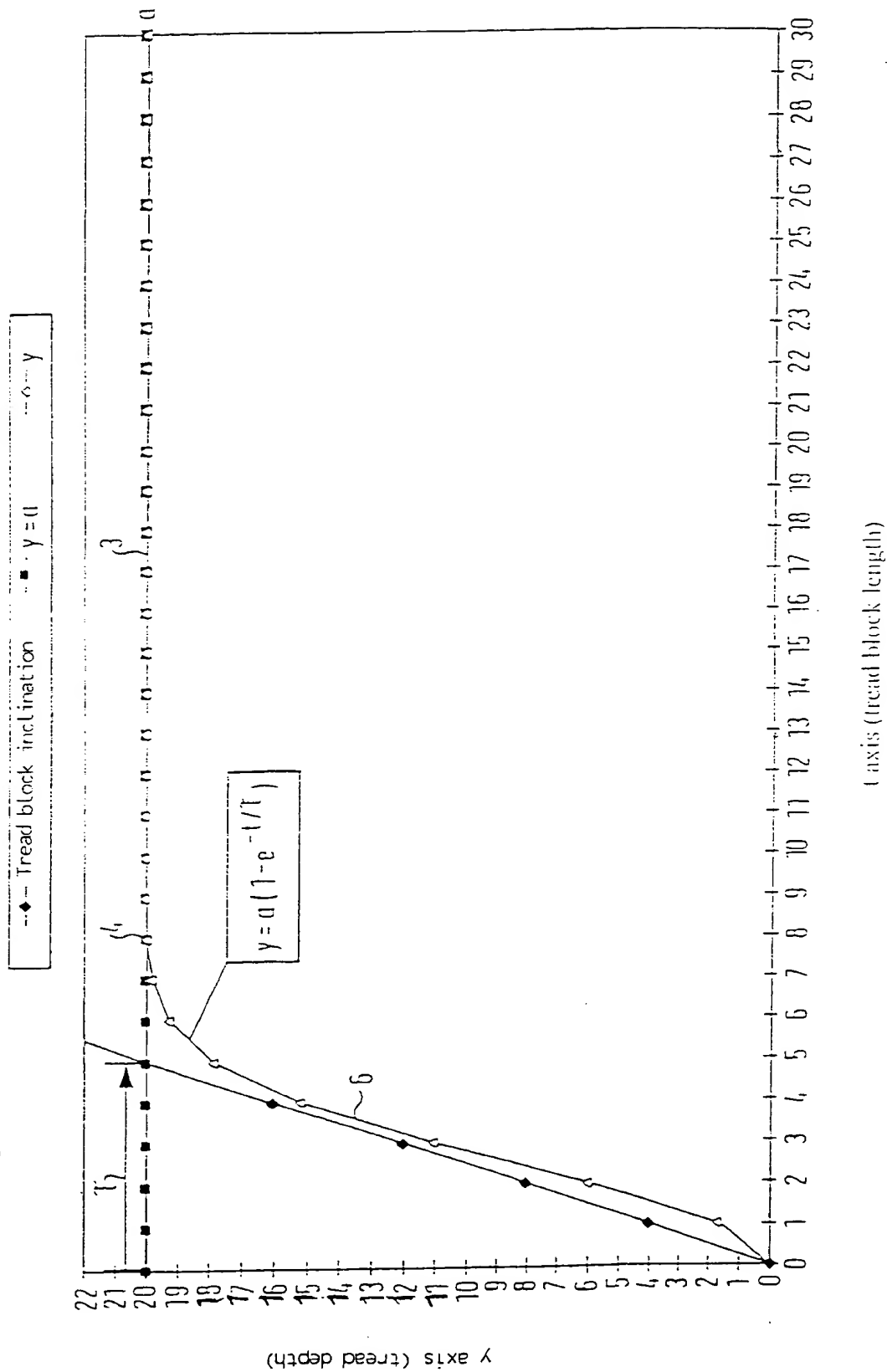


FIG. 4

Groove angle 11° at tread run-out
Groove angle 17° at tread entry

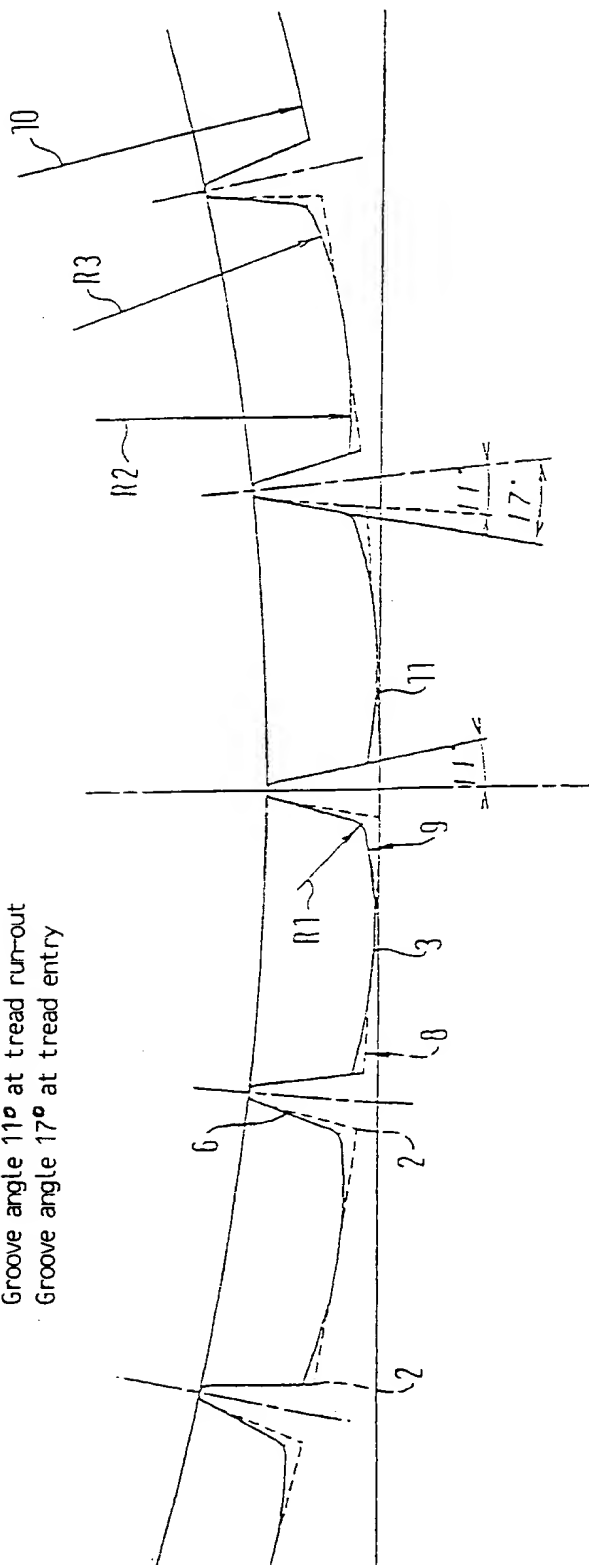


FIG. 5

Groove angle 0° at tread run-out
 Groove angle 23° at tread entry

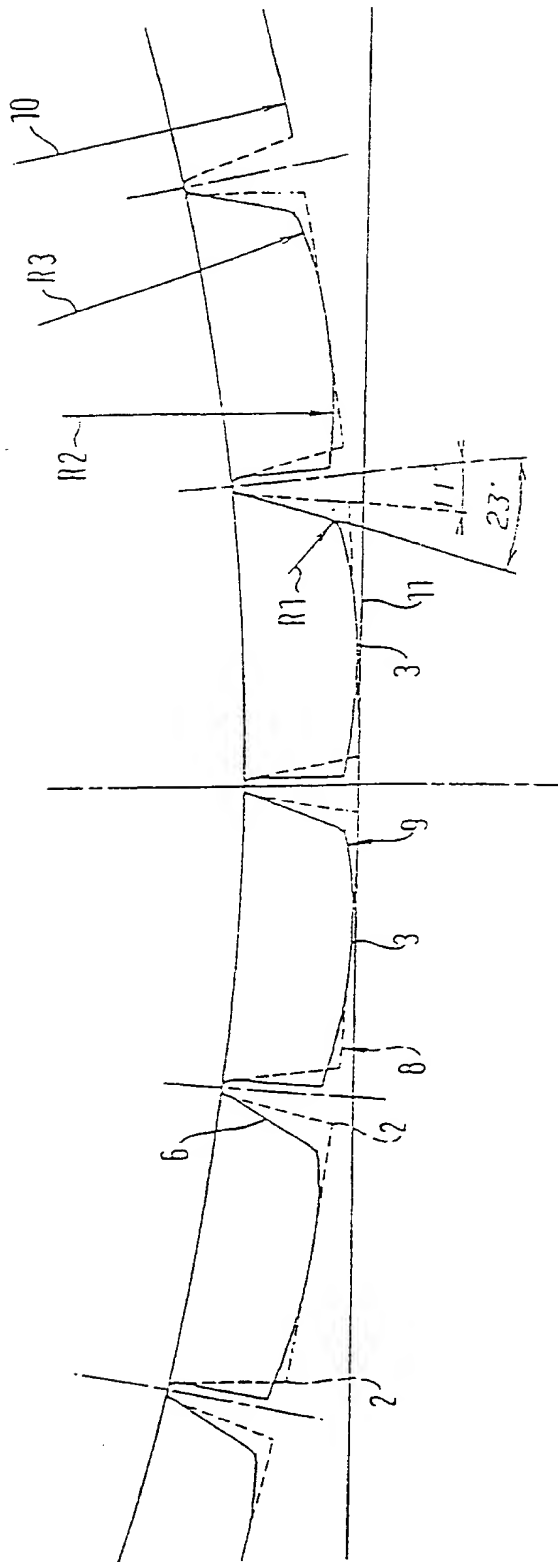
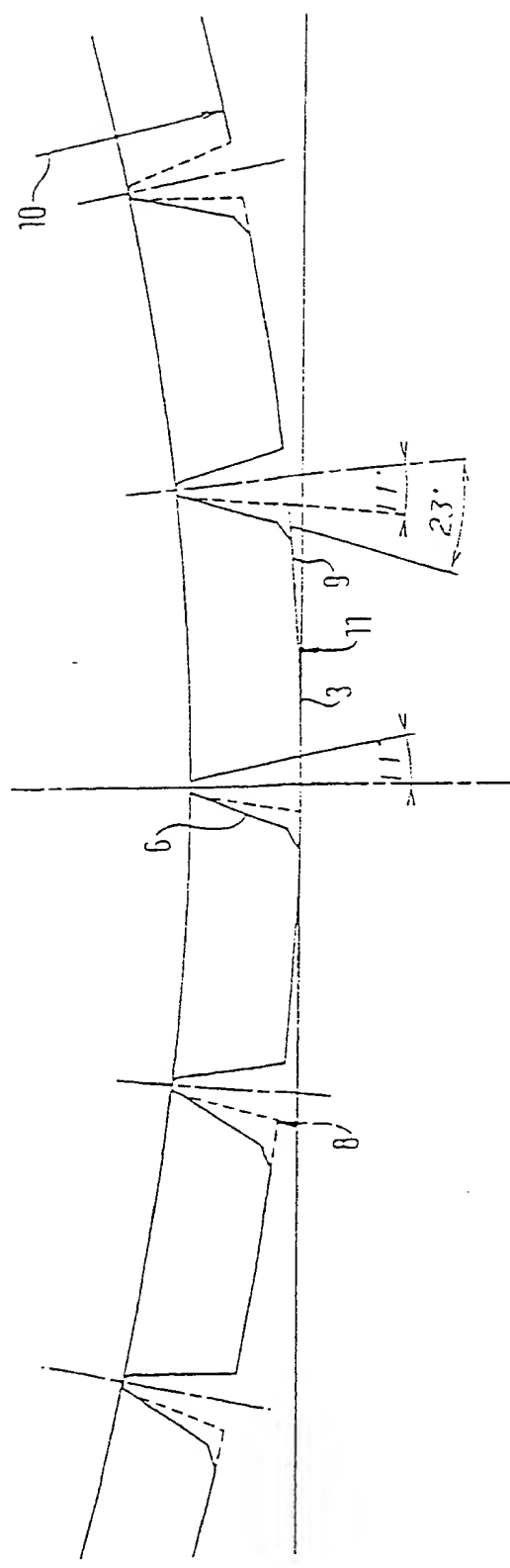


FIG. 6

Groove angle 11° at tread run-out
Groove angle 23° at tread entry



INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 00/06919

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60C11/13

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 10, 30 November 1995 (1995-11-30) & JP 07 186623 A (YOKOHAMA RUBBER CO LTD:THE), 25 July 1995 (1995-07-25) abstract ---	1,2,7, 10,11
X	US 5 358 022 A (ATTINELLO JOHN S ET AL) 25 October 1994 (1994-10-25) column 8, line 17 - line 58; figures 4,4A ---	1,2,7,8
X	EP 0 925 957 A (BRIDGESTONE CORP) 30 June 1999 (1999-06-30) page 2, line 6 - line 15; figures 3,4 --- -/--	1,6

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 015, no. 427 (M-1174), 30 October 1991 (1991-10-30) & JP 03 178809 A (YOKOHAMA RUBBER CO LTD:THE), 2 August 1991 (1991-08-02) abstract ---	1,2,6,9
X	EP 0 652 119 A (BRIDGESTONE CORP) 10 May 1995 (1995-05-10) claims; figures	1,6
A	---	15
A	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 05, 30 May 1997 (1997-05-30) & JP 09 002019 A (BRIDGESTONE CORP), 7 January 1997 (1997-01-07) abstract ---	14
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 13, 30 November 1998 (1998-11-30) & JP 10 203118 A (YOKOHAMA RUBBER CO LTD:THE), 4 August 1998 (1998-08-04) abstract ---	7,8,14
A	DE 41 07 051 A (UNIROYAL ENGLEBERT GMBH) 10 September 1992 (1992-09-10) column 4, line 5 - line 33; figures -----	12,13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 00/06919

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 07186623	A	25-07-1995	NONE	
US 5358022	A	25-10-1994	US 5327952 A	12-07-1994
			AU 646927 B	10-03-1994
			AU 1212392 A	10-09-1992
			BR 9200608 A	10-11-1992
			CA 2054991 A	09-09-1992
			EP 0503405 A	16-09-1992
			JP 5092704 A	16-04-1993
			MX 9200891 A	01-09-1992
			TR 25971 A	01-11-1993
			BR 9303901 A	19-04-1994
			CA 2101862 A	03-04-1994
			DE 69316299 D	19-02-1998
			DE 69316299 T	09-07-1998
			EP 0590526 A	06-04-1994
			ES 2112941 T	16-04-1998
			MX 9306044 A	29-04-1994
			US 5386862 A	07-02-1995
EP 0925957	A	30-06-1999	JP 11189013 A	13-07-1999
JP 03178809	A	02-08-1991	JP 2900271 B	02-06-1999
EP 0652119	A	10-05-1995	JP 7304309 A	21-11-1995
			DE 69408092 D	26-02-1998
			DE 69408092 T	07-05-1998
			ES 2111261 T	01-03-1998
			US 5690761 A	25-11-1997
JP 09002019	A	07-01-1997	NONE	
JP 10203118	A	04-08-1998	US 6065517 A	23-05-2000
DE 4107051	A	10-09-1992	FR 2673578 A	11-09-1992